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ABSTRACT

From 1968 to 1970, three separate studies of North Carolina science teachers were conducted in the areas of biology (N=177), chemistry (N=101), and physics (N=71). The three studies shared three major purposes, to determine: the academic preparation of the science teachers being investigated, (2) the relationship between the level of academic preparation and school size, and (3) the relationship between the level of academic preparation and the amount of supplement to the state salary schedule paid by the employing school district. A fourth study of advanced high school biology teachers (N=100) was conducted: (1) to determine the academic preparation of advanced biology teachers and other factors such as teaching loads and years of experience and (2) to compare the preparation of teachers of advanced biology with that of teachers of tenth-grade biology. Results of these studies are summarized in this document. Comments and recommendations are made in four areas: teacher certification, teacher preparation programs, school practices, and future research. (Author/DC)

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Science Education Report

THE PREPARATION OF HIGH SCHOOL SCIENCE TEACHERS IN NORTH CAROLINA

Baseline Data For The 1980's

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Introduction

As we move into the 1980's, much attention is being directed toward the status of science teaching in our schools. It is generally recognized that the quality of science programs is in large measure dependent upon the ability of school systems to attract and retain qualified science teachers. One index of teacher quality is the level of academic preparation.

Prior to 1968 little quantitative data were available about the academic preparation of North Carolina high school science teachers. Because of a need for information for assessment and related planning activities, a series of studies were undertaken at North Carolina State University. The results of these studies are summarized in this paper; the results and implications discussed at the end of this paper are those which were formulated at the conclusion of the studies in 1971. Thus, not only can the results reported serve as baseline data for studies in the 1980's, but comments we made ten years ago can be viewed in their historical perspective.

Scope of the Studies

Schauer (1968), Hobbs (1968), and Hunter (1970) investigated the preparation of biology, chemistry, and physics teachers respectively. These studies had three common purposes: (a) to determine the academic preparation of the science teachers being investigated, (b) to determine the relationship between the level of academic preparation and school size, and (c) to determine the relationship between the level of academic preparation and the amount of supplement to the state salary schedule paid by the employing school district. In addition to these three central purposes, other useful information was obtained about teaching loads, class size, and recency of training.

All three studies involved the science teachers in a stratified random sample of 103 high schools taken from the 629 high schools in North Carolina that were in operation during the 1967-68 school year. Data were obtained on 177 biology teachers, 101 chemistry teachers, and 71 physics teachers from the records of the Department of Teacher Certification of the State Department of Public Instruction.

Royster (1971) investigated the preparation of teachers of advanced high school biology. The purpose of his study were (1) to determine the academic preparation of advanced biology teachers and other factors such as teaching loads and years of experience, and (2) to compare the preparation of teachers of advanced biology with that of teachers of tenth-grade biology. His findings are based on a random sample of 100 teachers of advanced biology selected from the 172 teachers so employed in North Carolina during the 1969-70 school year. He also used the records of the Department of Teacher Certification of the State Department of Public Instruction to obtain his data.

Biology Teachers

North Carolina biology teachers employed during the 1967-68 school year averaged 25.6 semester hours in biology, 10.3 semester hours in chemistry, 6.0 semester hours in mathematics, 4.1 semester hours in physics, and 1.4 semester hours in earth science. As might be expected, there was great diversity among the biology teachers with respect to their preparation in the sciences, with some of the largest deficiencies being in supporting areas. For example, only 34.0 per cent had taken a course in organic chemistry, only 57.6 per cent had a college course in physics, and only 35.1 per cent had a course in the earth sciences.

An analysis of the relationship between academic preparation and school size and between academic preparation and local salary supplement was performed by calculating the contingency coefficients between the various factors. The significance of each contingency coefficient was determined using the chi square test. In order to do these calculations, each biology teacher was placed in one of six categories. As an example of these categories, Level 0 was a high school biology teacher with less than one year of college biology. Level 5, or those biology teachers best prepared, included biology teachers having twenty-four or more semester hours in biology (including at least one course in botany and zoology beyond the introductory course), and one or more years of chemistry, one course in organic and/or biochemistry, six or more semester hours in physics, six or more semester hours in mathematics, and at least one course in biology in the past five years. Nineteen, or slightly more than 10 percent, of the biology teachers were in Levels 4 and 5, whereas fifty teachers, or about 30 percent, were in Levels 0 and 1.

Although the relationships between academic preparation and school size and between academic preparation and amount of salary supplement were positive, they were not significant at the .05 level. This refutes the common belief that the largest schools and the schools that pay the largest supplement to the state salary schedule attract the teachers with the best academic preparations.

Chemistry Teachers

Chemistry teachers employed in North Carolina schools during the 1967-68 school year averaged 17.2 semester hours in chemistry, 20.3 hours in biology 9.7 in mathematics, 6.8 in physics, and 2.4 in science. Almost one-third, or

32.6 per cent of the chemistry teachers had less than nine semester hours of college chemistry, and thus could be considered very poorly prepared. Many of the chemistry teachers also taught biology as part of their teaching assignment and had specialized in biology in their undergraduate programs.

It was found that the relationship between academic preparation of chemistry teachers and size of salary supplement was positive but not significant at the .05 level. However, the relationship between academic preparation and school size was significant at the .05 level. Apparently, many of the larger schools with several sections of chemistry were able to employ a teacher with specialization in chemistry, whereas chemistry in smaller schools often is taught by teachers with other specializations.

Physics Teachers

The physics teachers studied averaged 9.9 semester hours in physics, 18.5 in mathematics, 16.2 in chemistry, 19.2 in biology, and 5.2 in earth science. It was found that 7 per cent of the physics teachers in the sample had never had a college-level physics course; almost 33 per cent of the teachers had less than eight semester hours, or the equivalent of two courses in physics. Small student enrollments prevented most high schools in the sample from having a full-time physics teacher. Eighty percent of the teachers in the sample taught only one physics class per day. It was concluded that physics teachers in North Carolina are not as well prepared as biology and chemistry teachers.

The relationship between school size and the academic preparation of physics teachers was positive but not significant as the .05 level. However, the relationship between academic preparation and size of salary supplement was significant at the .05 level. This is not surprising since it is the

school districts with the largest salary supplement that in general have the most sections of physics per high school. Thus, they are in a position to hire teachers with a specialization in physics to teach physics as a major part of their teaching loads.

Advanced Biology

Advanced biology is the most frequently offered advanced science course in North Carolina high schools, with 165 of 629 high schools offering it in the 1969-70 school year. Royster (1971) found that, in general, the academic preparation of a random sample of 100 of the 172 advanced biology teachers exceeded that of the tenth-grade biology teachers. The average semester hours of credit earned by the advanced biology teachers is 36.0 in biology, 13.3 in chemistry, 5.7 in physics, 6.6 in mathematics, and 1.7 in earth science. The advanced biology teachers had certain of the same weaknesses in preparation as tenth-grade biology teachers; only 56 percent had earned credit in organic chemistry, and only 9 percent had taken a course in biochemistry.

Discussion of the Results and Their Implications - As Viewed in 1971

The findings of these four studies on the academic preparation of North Carolina science teachers do not, of course, serve as a basis for drawing broad conclusions about the quality of the science programs in our state. They do, however, provide valuable data for use in making decisions about future policies and practices with respect to certification, teacher assignments, inservice education, and the nature of school science programs. Specifically, it is felt that the findings support the following suggestions and recommendations:

1. Certification. The guidelines for the approval of teacher education programs currently in use by the State Department of Public Instruction in North Carolina provide for an adequate preparation in science and supporting subjects. However, many science teachers are entering our profession with substandard certificates or are certified in another subject area and teaching "out of field." Steps should be taken as soon as possible to insure that all new science teachers entering teaching are adequately prepared--this means certifying and employing as science teachers only those who have placed a major emphasis on science in their college work.

North Carolina requires that a teacher must earn at least six hours of certificate renewal credit during each five-year period. In light of the poor academic preparation of many North Carolina science teachers, it seems reasonable that they should be required to take part or all of this work in science.

2. Teacher Preparation Programs. The status of the academic preparation and working conditions of North Carolina science teachers suggests several things for both the preservice and inservice education of teachers. At the preservice level, ways must be found to attract more students to teaching careers in the physical sciences. Since many schools teach only one section of high school physics and only one or two sections of chemistry it would appear desirable to prepare teachers to handle combinations such as chemistry-physics and physics-mathematics.

At the inservice level, the two major tasks are that of bringing the academic preparation of those practicing science teachers who are poorly prepared up to some minimum level and that of providing for the continued up-dating of all science teachers. Even though dozens of institutes supported by the National Science Foundation and other groups have been

conducted during the last 15 years, much remains to be done in just upgrading the academic preparation of science teachers. Most of our present inservice programs should be continued, plus additional types be considered. The use of Educational Television and inservice programs conducted by the school systems themselves and staffed by superior high school teachers appear to be two promising possibilities.

3. School Practices. School systems are in a position to do many things to raise the average level of the academic preparation of science teachers and, hopefully, thus improve their science programs. They can begin by employing only qualified science teachers if they are available and assigning only qualified science teachers to teach science classes. They also may need to consider different ways of using a teacher's time. For example, in the case of the physical sciences in which there are small enrollments in many schools, it may be desirable for the science teacher to travel to two or more schools. Not only would students profit from having a well-qualified teacher, but it might be easier to recruit such a teacher if he would have a full load in his major area of interest. There also might be savings in acquiring equipment and materials, since much of it might be used in more than one school.

Small enrollments in certain science courses and poorly qualified teachers appear to be part of a cycle. As part of breaking this cycle, it may be necessary to develop new programs more attractive to students with varied academic backgrounds and interests. This is especially true in the physical sciences where the courses are all elective.

Educational technology may represent another means that can be used to improve science instruction at a time when many teachers are poorly

qualified. The Department of Public Instruction in North Carolina has broadcast a supplementary program in physical science at the ninth-grade level for several years. Perhaps programs also should be considered in other areas and especially in physics and chemistry. Programmed instruction and other types of student self-pacing programs represent other possibilities of reducing the negative effects of poorly prepared science teachers.

4. Implications for Future Research. Since the studies described in this article were undertaken, state and national conditions have changed in a way as to make our findings all the more valuable. With emerging teacher surpluses, some are arguing that the level of academic preparation of science teachers will improve--that school systems will replace poorly prepared teachers with teachers with better academic preparations. The findings of our four studies would serve as a base line and allow us to determine what changes in the academic preparation of science teachers do occur in North Carolina during the next five or 10 years.

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